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FUEL FIRE TESTS OF POLYTETRAFLUOROETHYLENE ANTI-EXPOSURE SUIT

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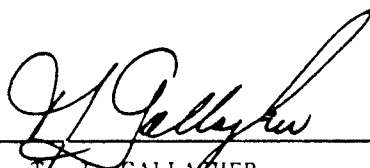
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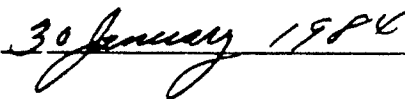
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HEAT AND FLAME TESTS OF PTFE ANTI-EXPOSURE SUITS

The development and composition of the laminate material containing a polytetrafluoroethylene (PTFE) layer was described previously (1). It is described as being composed of three layers.

1. A fire resistant aramid twill face
2. The PTFE center
3. A nylon tricot back.

When fabricated into clothing, the nylon layer is on the inside. Three anti-exposure suits with slight variation in manufacture were tested in this series.

METHOD

The method for the fuel fire tests is that developed at the Naval Air Development Center (2) with some variations. The mannequins were provided with 20 leather patches 3 in x 3 in, each of which held six temperature sensing paper strips 1/4 in x 2-1/2 in. Each paper strip of the set was fabricated to change from gray to black at the temperature stamped on its face, and the values were 120, 130, 140, 160, 210 and 220° F. The locations of the twenty leather patches are indicated in Table I and are distributed as follows: ten to the torso, front and back; eight to the legs and one on each arm, as shown in figure 1.

The mannequins were then dressed in cotton underwear consisting of a T shirt and trunks and a standard Nomex flight suit and finally the test assembly. They were given a 3-second exposure in a fire fueled by JP-4. The heat of the flames was measured by a Hy Cal transducer which was located near the waist of the mannequin.

RESULTS

The results from the sensors previously described are shown in table II. In the three tables shown, the first alphanumeric column is the location of the sensor from table I. The six remaining columns represent the temperatures measured or tested. If a sensor changed color, its value is written out, if not a zero is entered. Thus in the first table for the test, PTFT 2216090, no sensors turned at the location UT2F, upper torso 2 front, left breast, therefore zeros are entered; but for the same location on the mannequin's back, the 120 and 130° sensors were changed. Of the three tests, a temperature of 160° representing a third-degree burn, was reached at one location, back of the right leg in the third test.

Photographic Coverage — The fire pit was covered by two movie cameras, both of which viewed the mannequin as it came out of the flames. Two of the test suits came through with trails of smoke. These are shown in figures 1 through 6 and figures 13 through 18, showing front, back, and side views before and after the exposure. These suits show some shrinkage but otherwise continue to provide a protective barrier. The third suit was different in that it did flame as it emerged from the flames, but it self-extinguished, and as with the others, it was still an integral garment that would be a barrier against fire.

DISCUSSION

From the tests carried out here, one could only conclude that PTFE serves as an adequate if not an excellent barrier against fire that a crewman may encounter on board a carrier deck. The only observation of a variant nature was the one suit that was flaming as it emerged from the flames, which is different from what is usually observed. Nomex as a rule comes out smoking. However, with this small sample, it would not seem profitable to speculate on this single observation. The flames rapidly self-extinguished.

The run identification number appears above each matrix. On the left margin are the 20 mannequin locations described in Table I. The six columns represent six temperature sensors for each location. Zeroes indicate that the temperature was not reached for that location.

TABLE I. SENSOR SITES

	<u>Current</u>	<u>Past</u>
1.	UT2F Upper Torso 2 Front, left breast	T1
2.	UT2B Upper Torso 2 Back	T2
3.	UT3F Upper Torso 3 Front, right breast	T3
4.	UT3B Upper Torso 3 Back	T4
5.	UT6F Upper Torso 6 Front, naval	T5
6.	UT6B Upper Torso 6 Back	T6
7.	LT1F Lower Torso 1 Front, pelvic area right	T13
8.	LT1B Lower Torso 1 Back	T14
9.	LT2F Lower Torso 2 Front, pelvic area left	T15
10.	LT2B Lower Torso 2 Back	T16
11.	RA1F Right Arm Upper 1 Front	A10
12.	LA1F Left Arm Upper 1 Front	A11
13.	RL1F Right Leg 1 Front, thigh	L6
14.	RL1B Right Leg 1 Back	L7
15.	RL3F Right Leg 3 Front, lower leg	L8
16.	RL3B Right Leg 3 Back	L9
17.	LL1F Left Leg 1 Front, thigh	L27
18.	LL1B Left Leg 1 Back	L18
19.	LL3F Left Leg 3 Front, lower leg	L19
20.	LL3B Left Leg 3 Back	L20

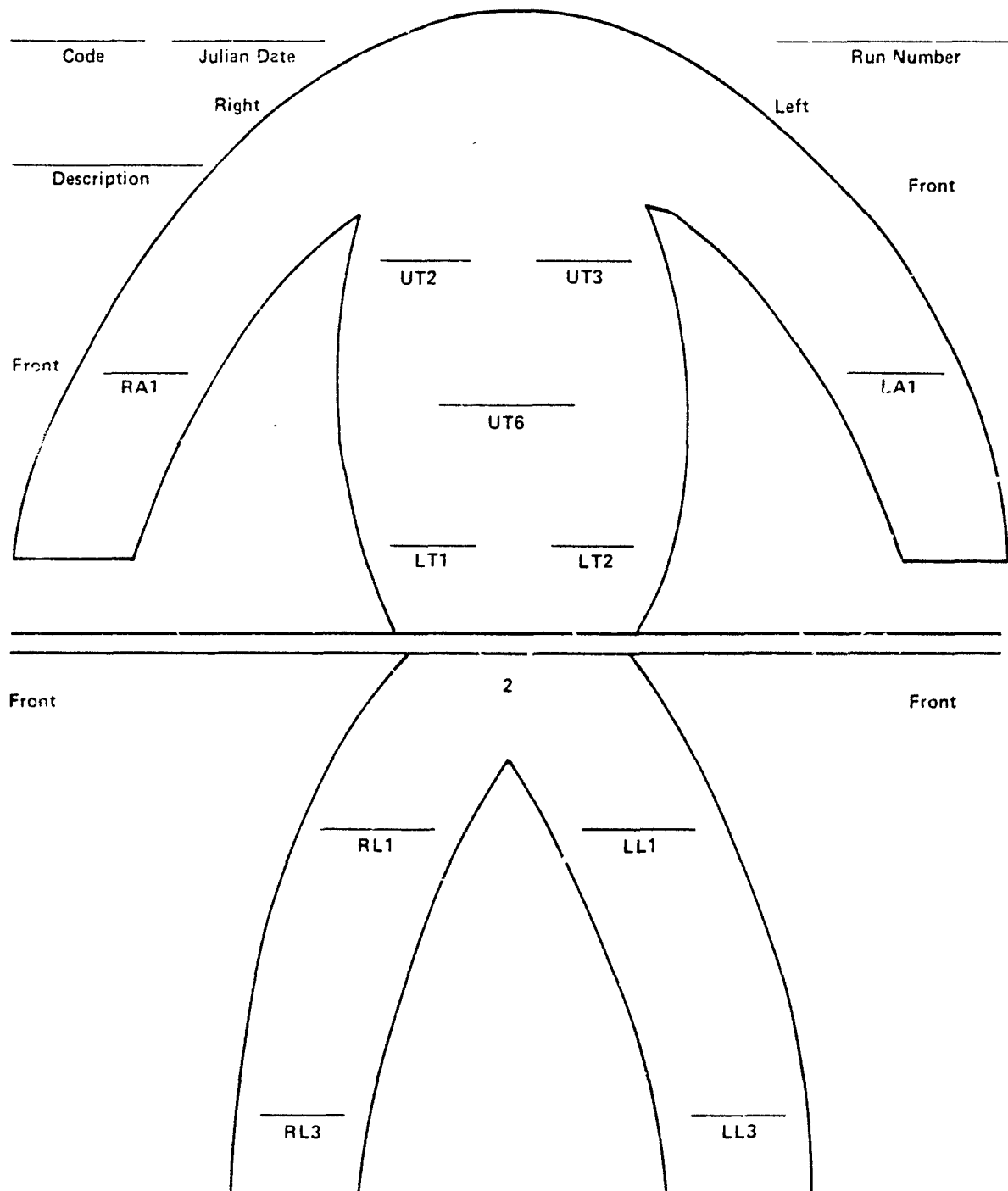
RESULTS OF VERTICAL FLAME TESTS

Vertical flame tests were carried out on twelve samples, six cut in the filling and six in the warp aspects according to Method 5903, Vertical Flame Resistance of Cloth, dtd July 20, 1978*. This test is carried out in an especially built enclosure under fixed, standardized conditions. The standardized flame burns for 12 seconds, and the following are determined:

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- After-flame "the time the specimen continues to flame after the burner flame is shut off".
- After-glow "the time the specimen continues to glow after it has ceased to flame".
- Char-length is a measure of the charring that took place, as determined by a specialized method.

*Federal Standard for Textile Test Methods, July 20, 1978



Sensor Mounting Sheets for the front side of the mannequin.
Two for the backside are similar except that the arms are not represented.

Figure 1. Sensor Mounting Sheet Showing Mannequin Sensor Locations

TABLE II. ACCUMULATED RUN DATA

PTFT2216090 3 SEC			PTKS2216091 3 SEC			PNKS2216092 3 SEC		
UT2F	0	0	0	0	0	0	0	0
UT2B	120	130	0	0	0	120	130	140
UT3F	0	0	0	0	0	0	0	0
UT3B	120	0	0	0	0	0	0	0
UT6F	0	0	0	0	0	0	0	0
UT6B	0	0	0	0	0	0	0	0
LT1F	120	130	0	0	0	0	0	0
LT1B	0	0	0	0	0	0	0	0
LT2F	120	130	0	0	0	120	0	0
LT2B	0	0	0	0	0	0	0	0
RA1F	120	130	0	0	0	0	0	0
LA1F	0	0	0	0	0	0	0	0
RL1F	120	130	140	0	0	120	130	0
RL1B	0	0	0	0	0	0	0	0
RL3F	0	0	0	0	0	0	0	0
RL3B	120	130	0	0	0	120	130	140
LL1F	120	130	140	0	0	120	130	140
LL1B	120	0	0	0	0	120	130	0
LL3F	0	0	0	0	0	0	0	0
LL3B	120	130	0	0	0	120	130	140

In carrying out the tests, two stopwatches were used to measure the duration of the afterflame and the afterglow. With this material there was no afterflame, the material stopped flaming before the burner was extinguished and this time was recorded as material flame out. The results are given in table III. The afterglow consisted of a very small area about the size of a pinpoint that persisted for these times. This was a consistent observation with these samples and is not considered to be hazardous.

TABLE III. VERTICAL FLAME TEST OF PTFE

Warp	After-Flame	After-Glow	Inches Char-Length	Flame-Out	After-Glow
=1	0.0	21.5	3.9	10	23.5
=2	0.0	20.5	4.0	8	24.5
=3	0.0	25.8	4.1	10	27.8
=4	0.0	23.0	3.8	10	25.0
=5	0.0	13.8	3.8	10	15.8
=6	0.0	15.6	2.6	8	19.6
			$3.7 \pm 0.6^{**}$	9.3 ± 1.0	22.7 ± 4.3
Filling					
=1	0.0	38.0	3.2	10*	40.0
=2	0.0	15.0	3.1	10*	17.0
=3	0.0	31.0	3.4	11	32.1
=4	0.0	28.8	3.4	9	31.8
=5	0.0	5.3	3.0	10	7.3
=6	0.0	32.0	2.4	9	35.0
			3.1 ± 0.4	6.5 ± 5.1	30.5 ± 13.8

*Average of the last four measurements

**Standard Deviation

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1. Lewycky, Jules Z., Development of Polytetrafluoroethylene Anti-exposure Suits, Naval Air Development Center Report No. NADC 81268-60, dtd 30 October 1981
2. Stoll, A. L., A. Munroe, M. A. Chianta, J. A. Piergallini and D. E. Zaccaria, A Facility and Method for Evaluation of Thermal Protection, Naval Air Development Center Report No. NADC-75286-40 dtd 1 December 1975

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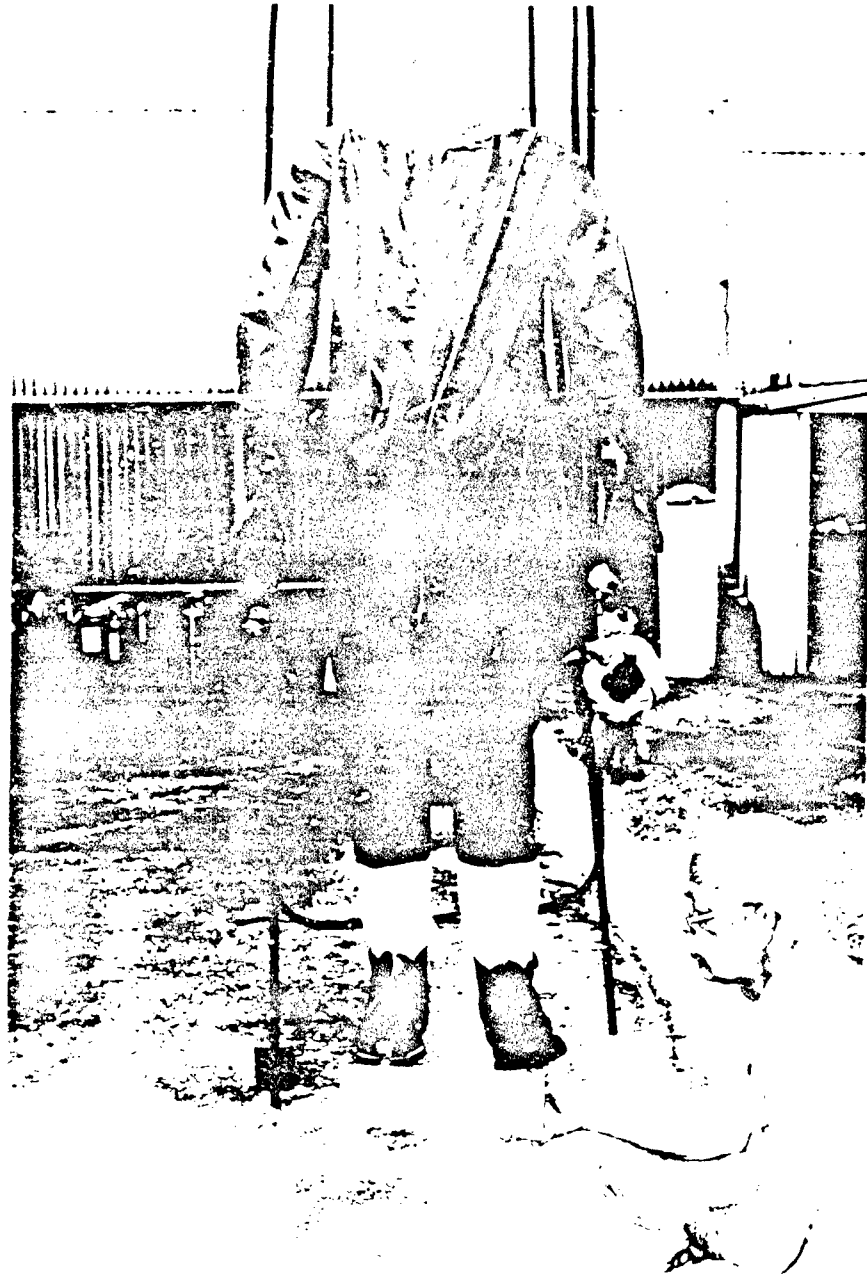


Figure 1. Sage Green, Blue Collar, Front, before

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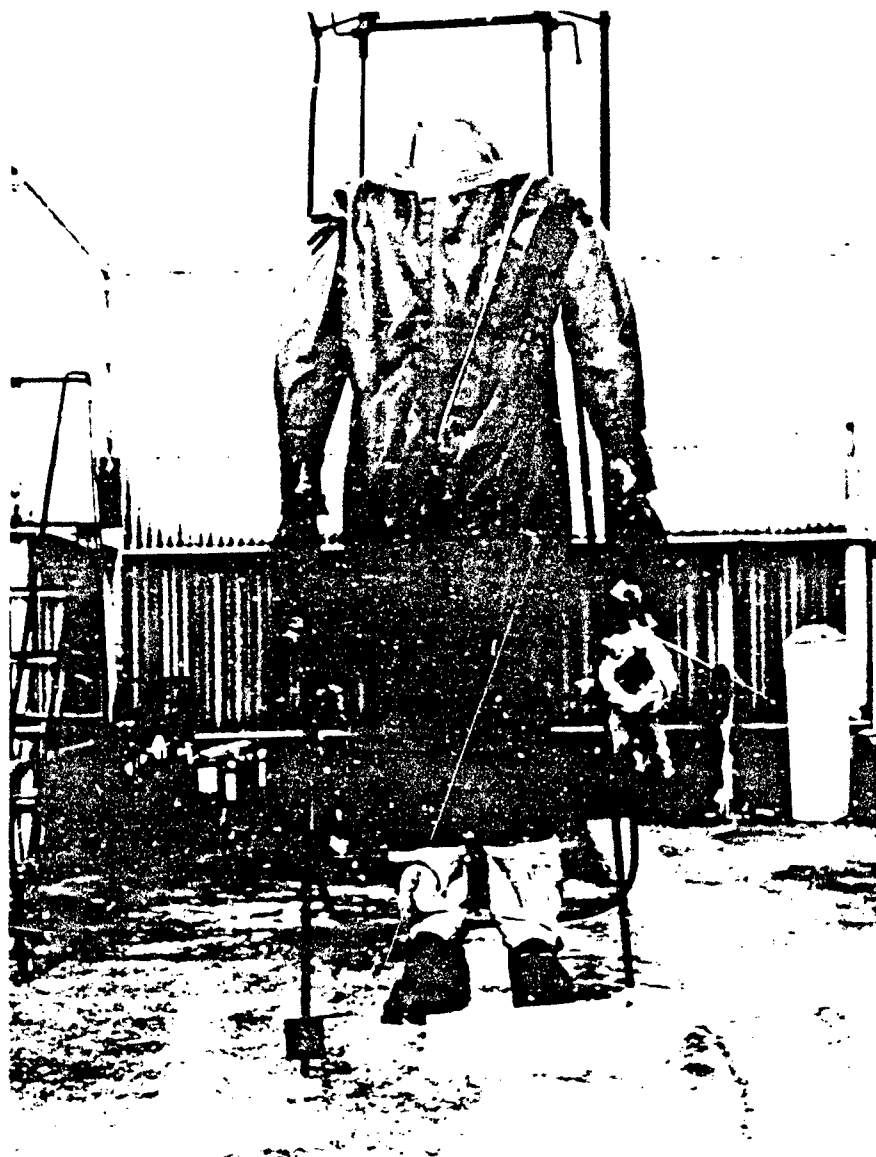


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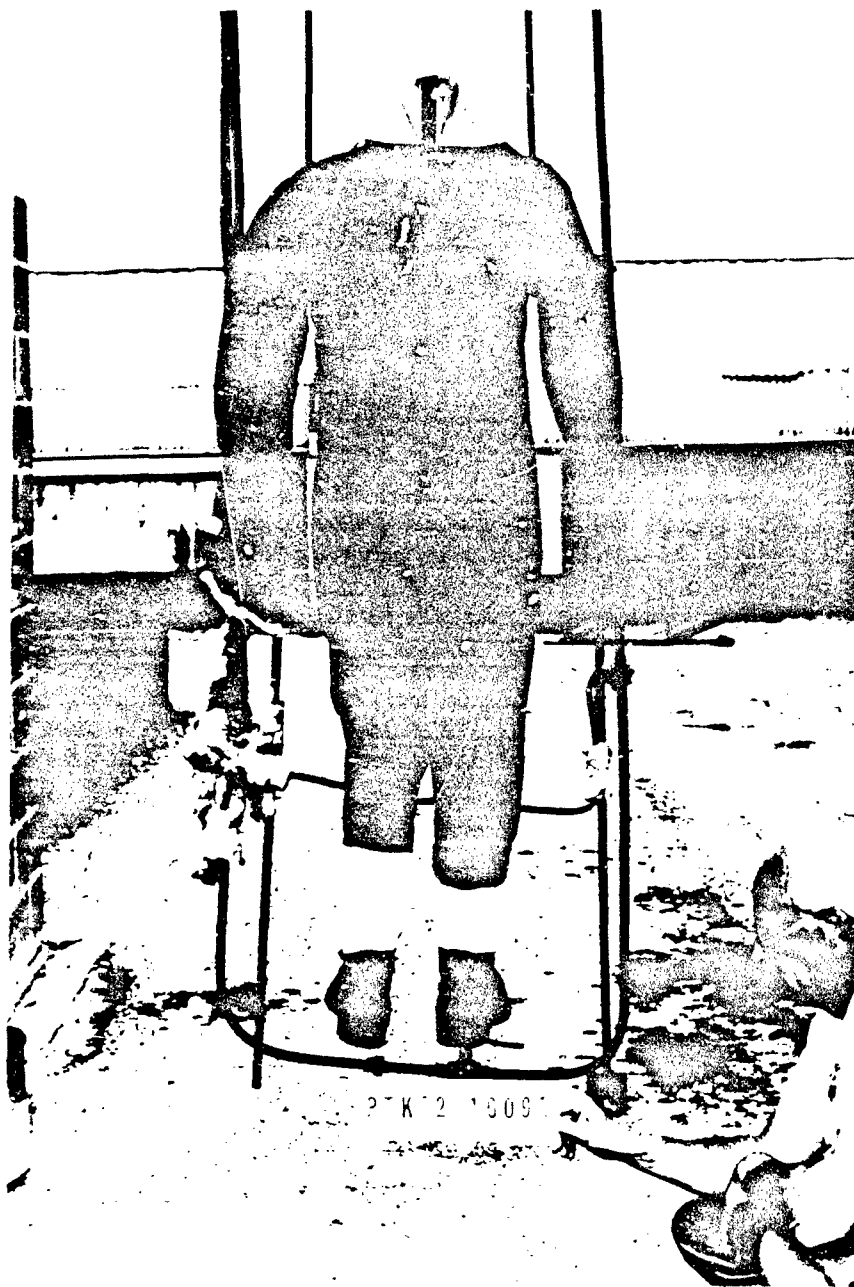


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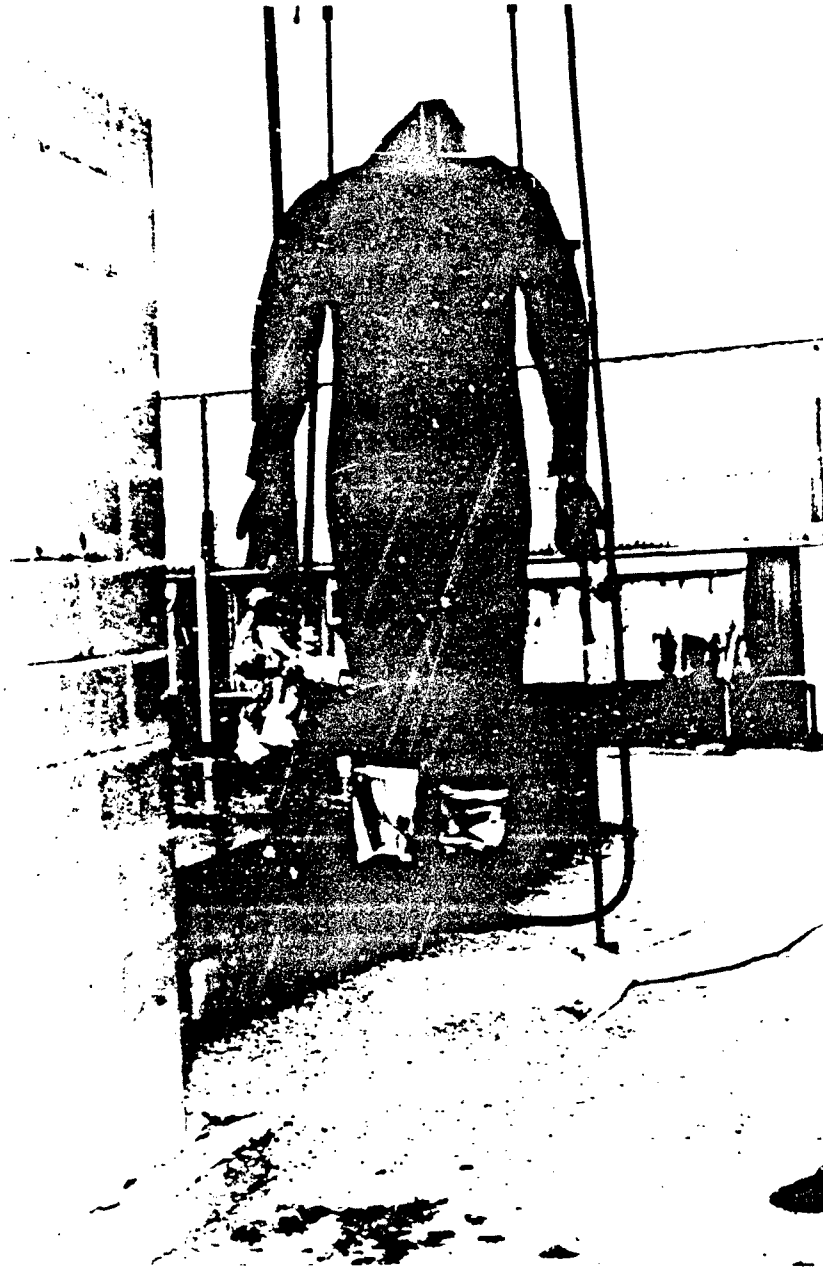


Figure 4. Sage Green, Blue Collar, Back, after

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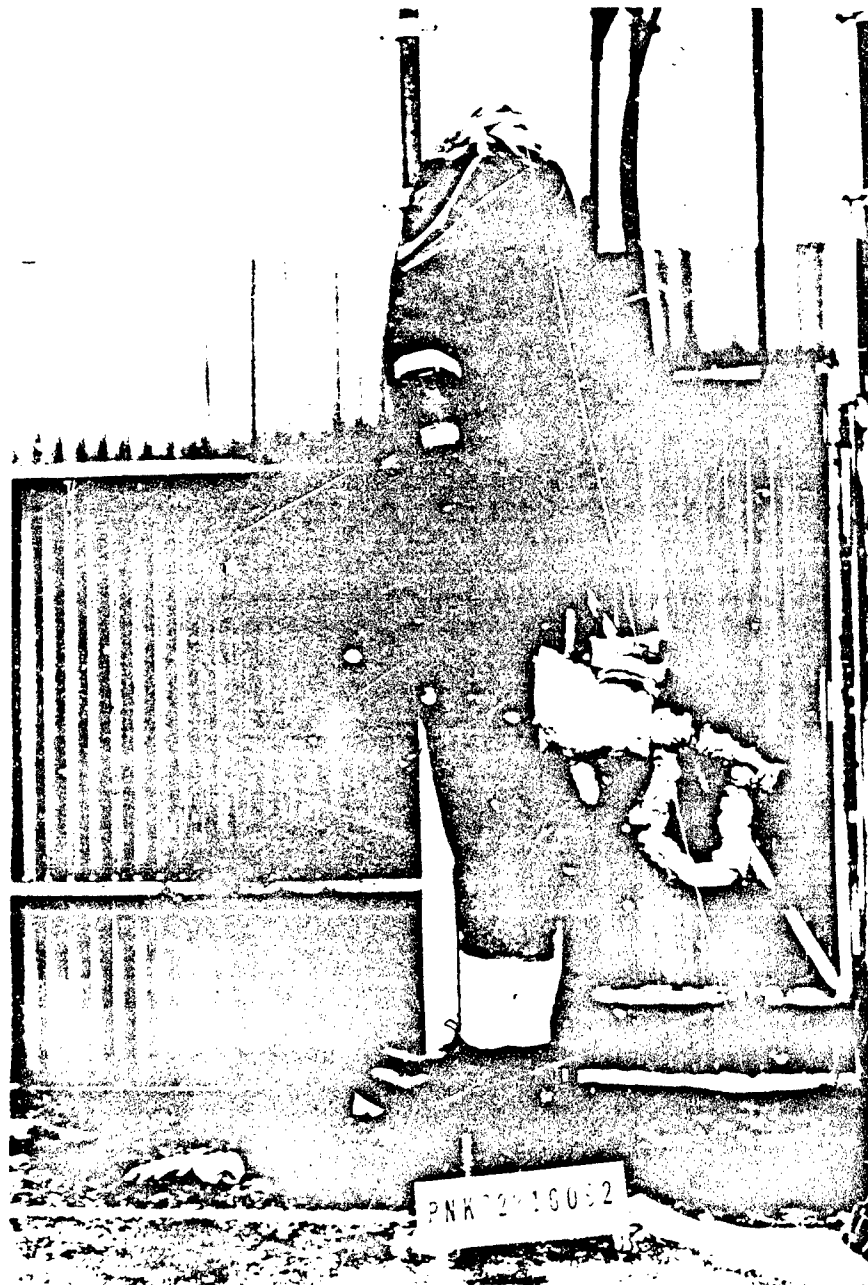


Figure 5. Sage Green, Blue Collar, Side, before

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Figure 6. Sage Green, Blue Collar, Side, after

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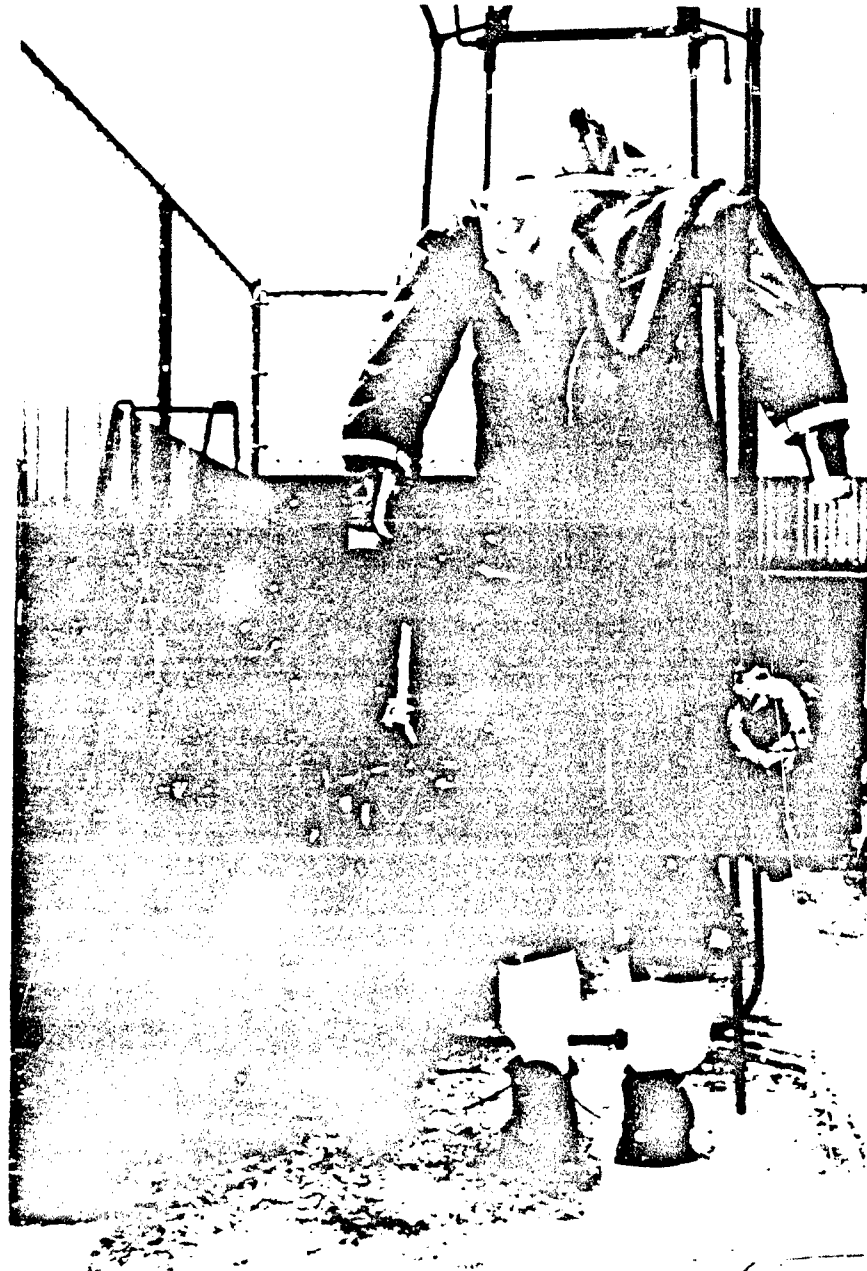


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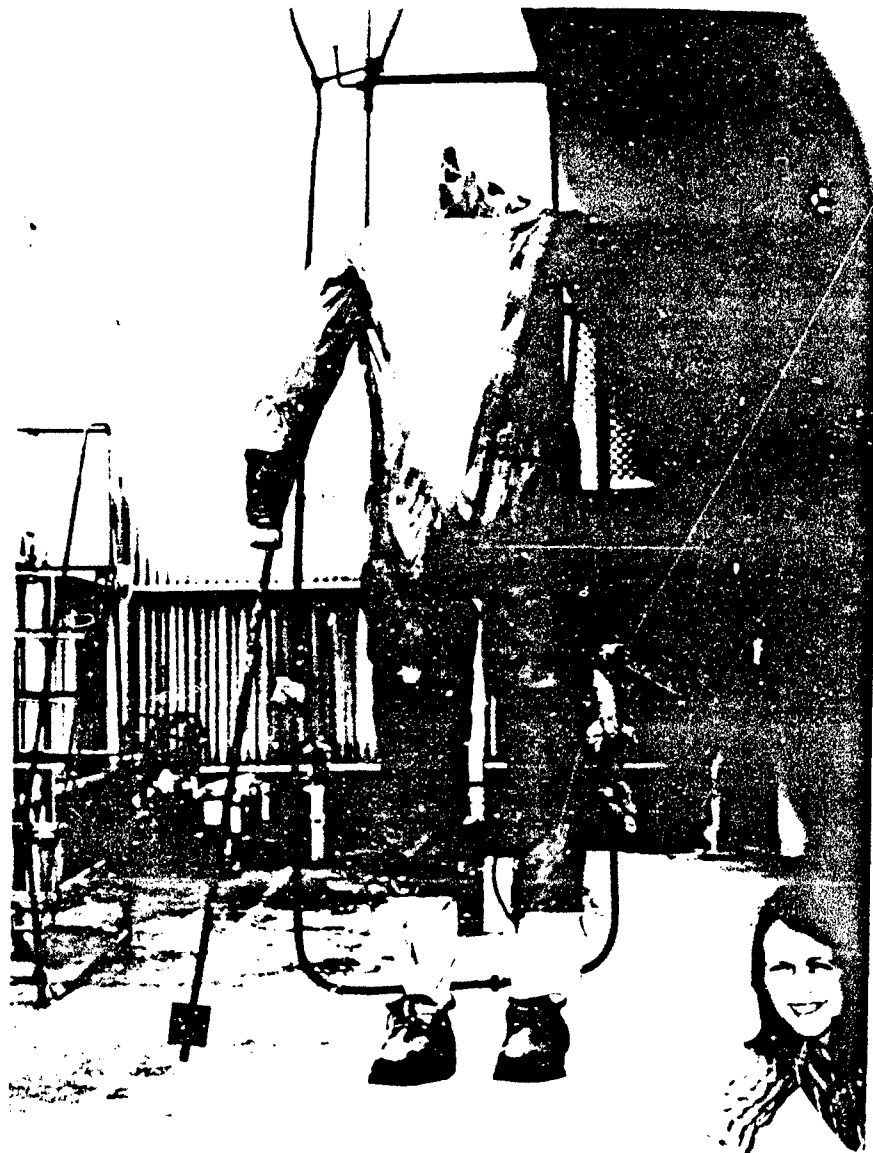


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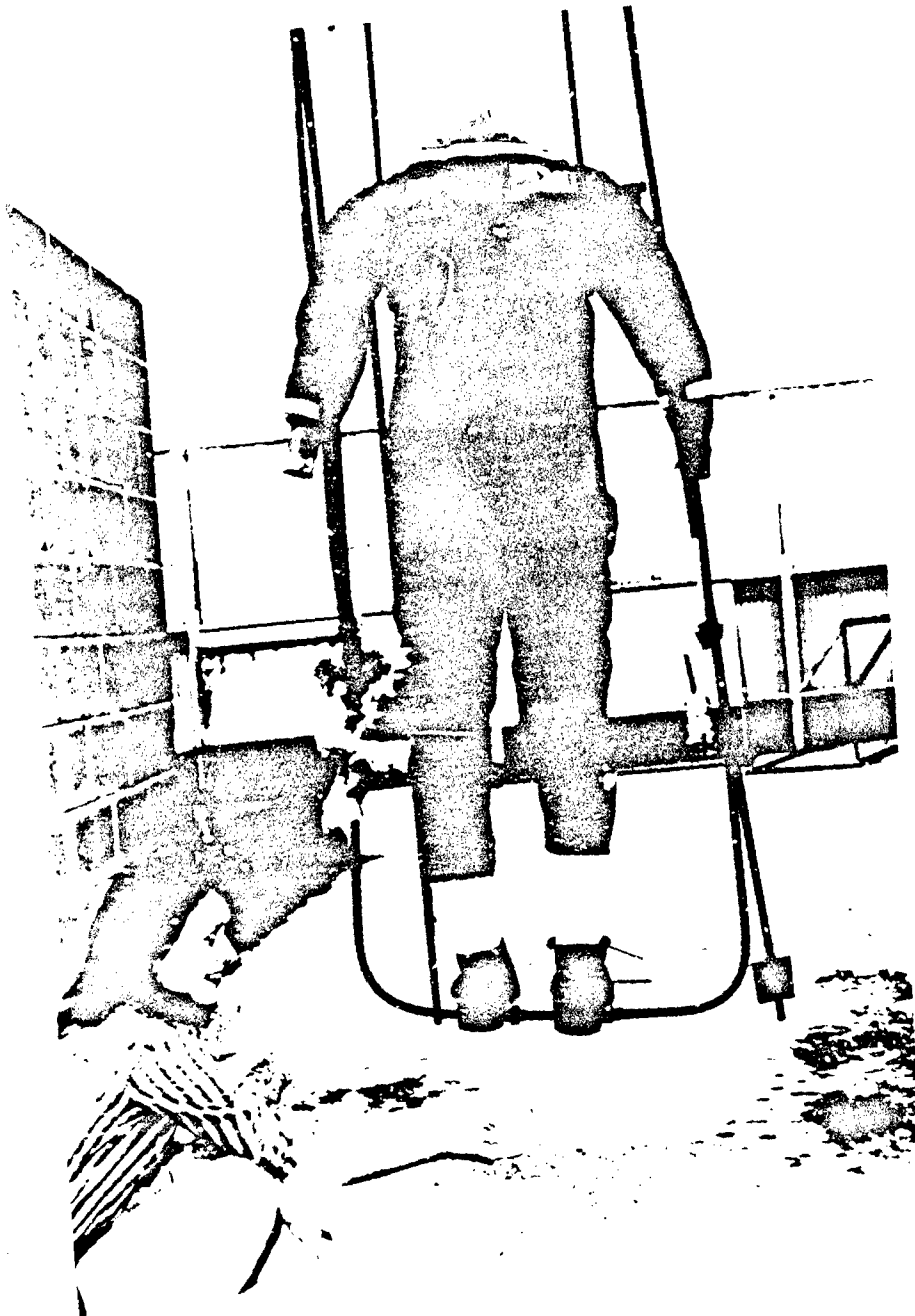


Figure 9. Sage Green, Back, before

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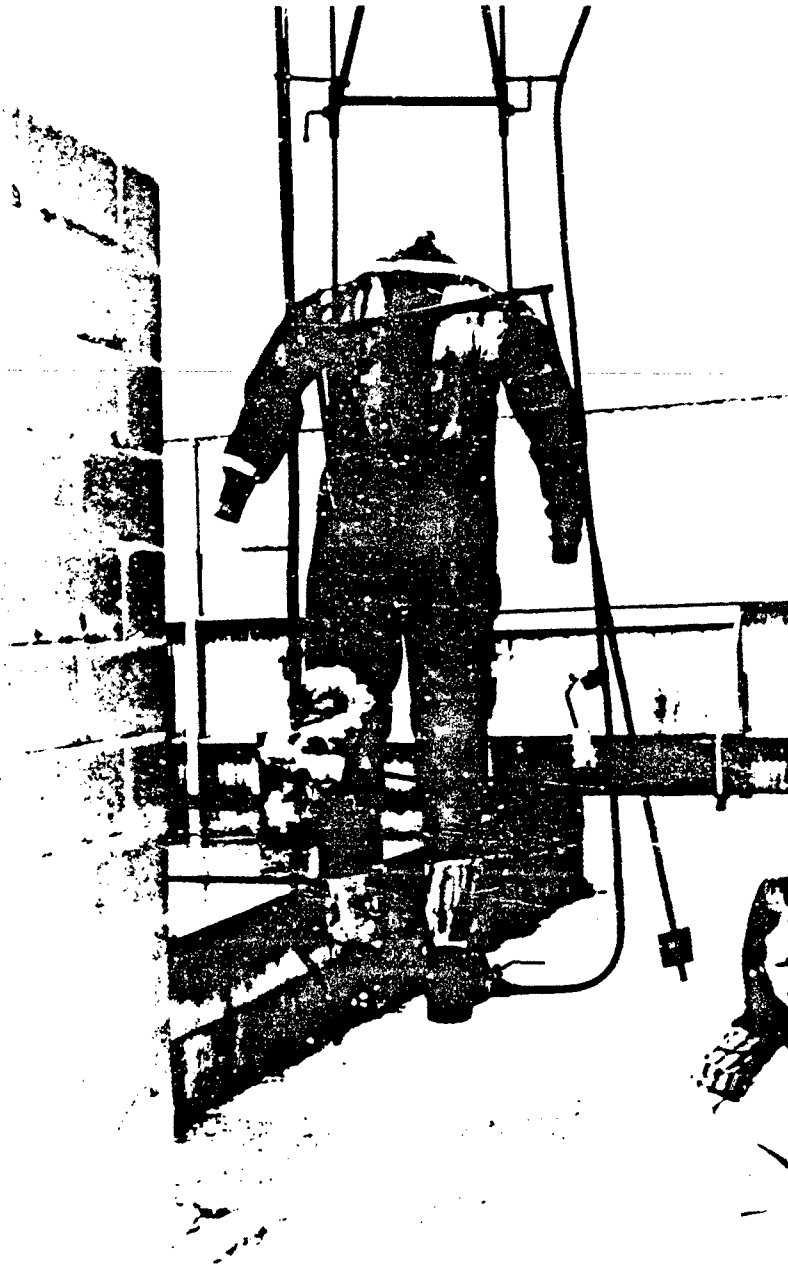


Figure 10. Sage Green, Back, after

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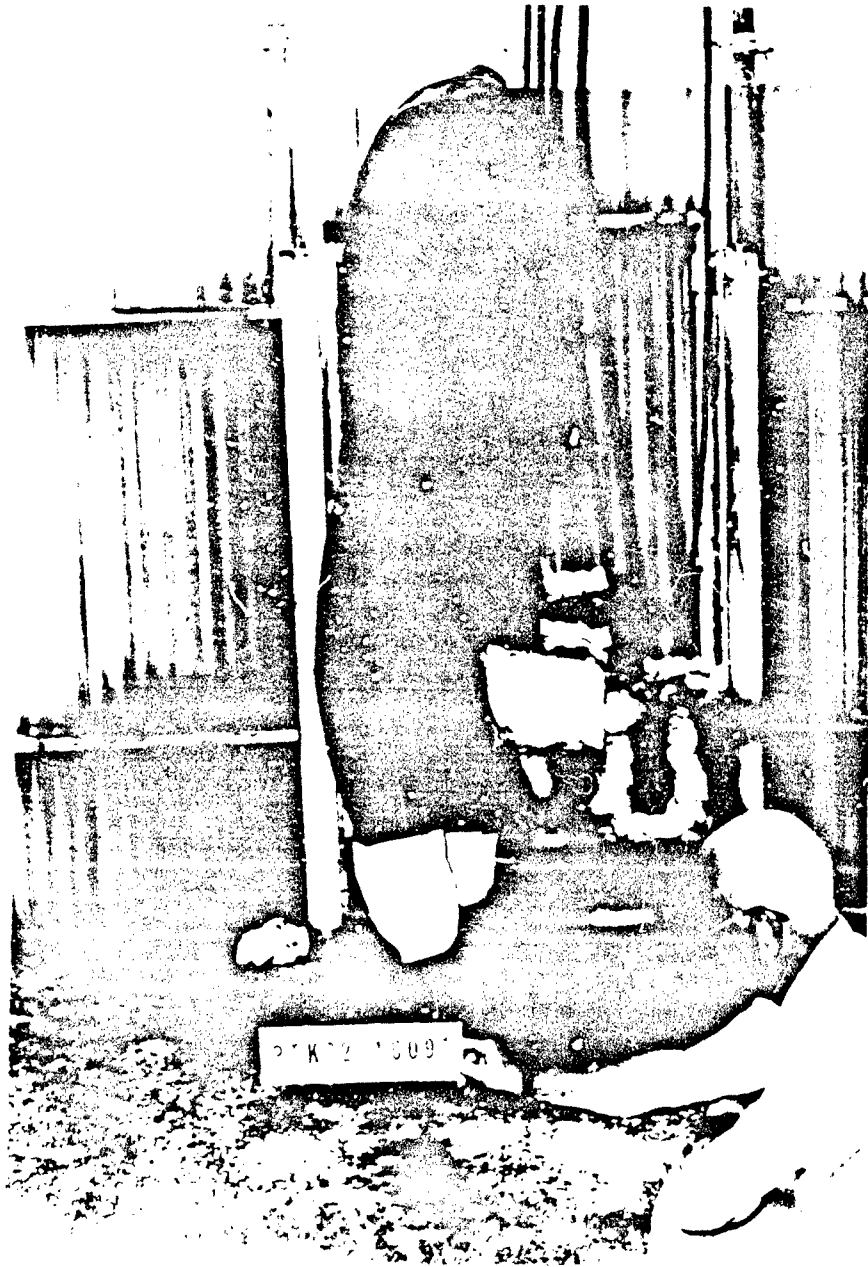


Figure 11. Sage Green, Side, before

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Figure 12. Sage Green, Side, after

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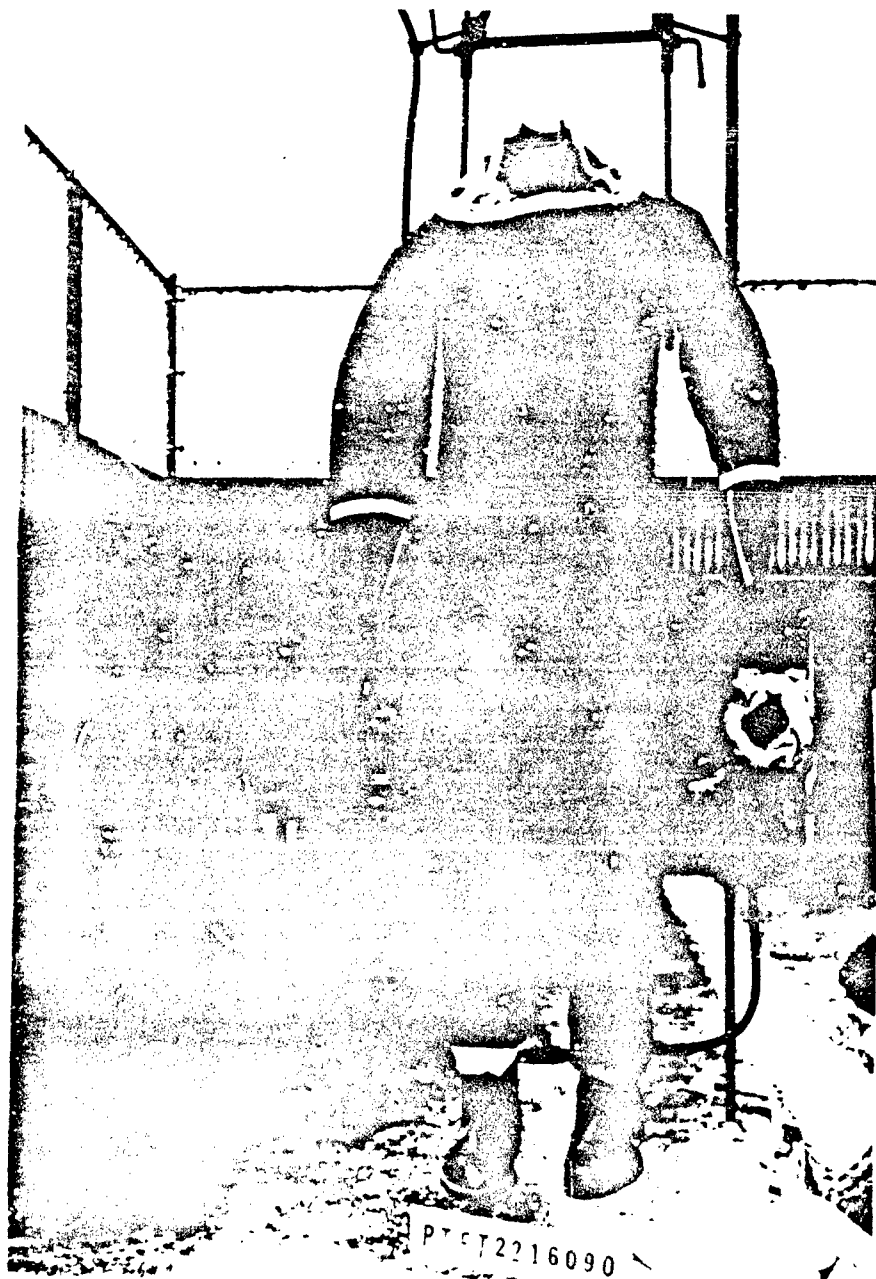


Figure 13. Orange, Front, before

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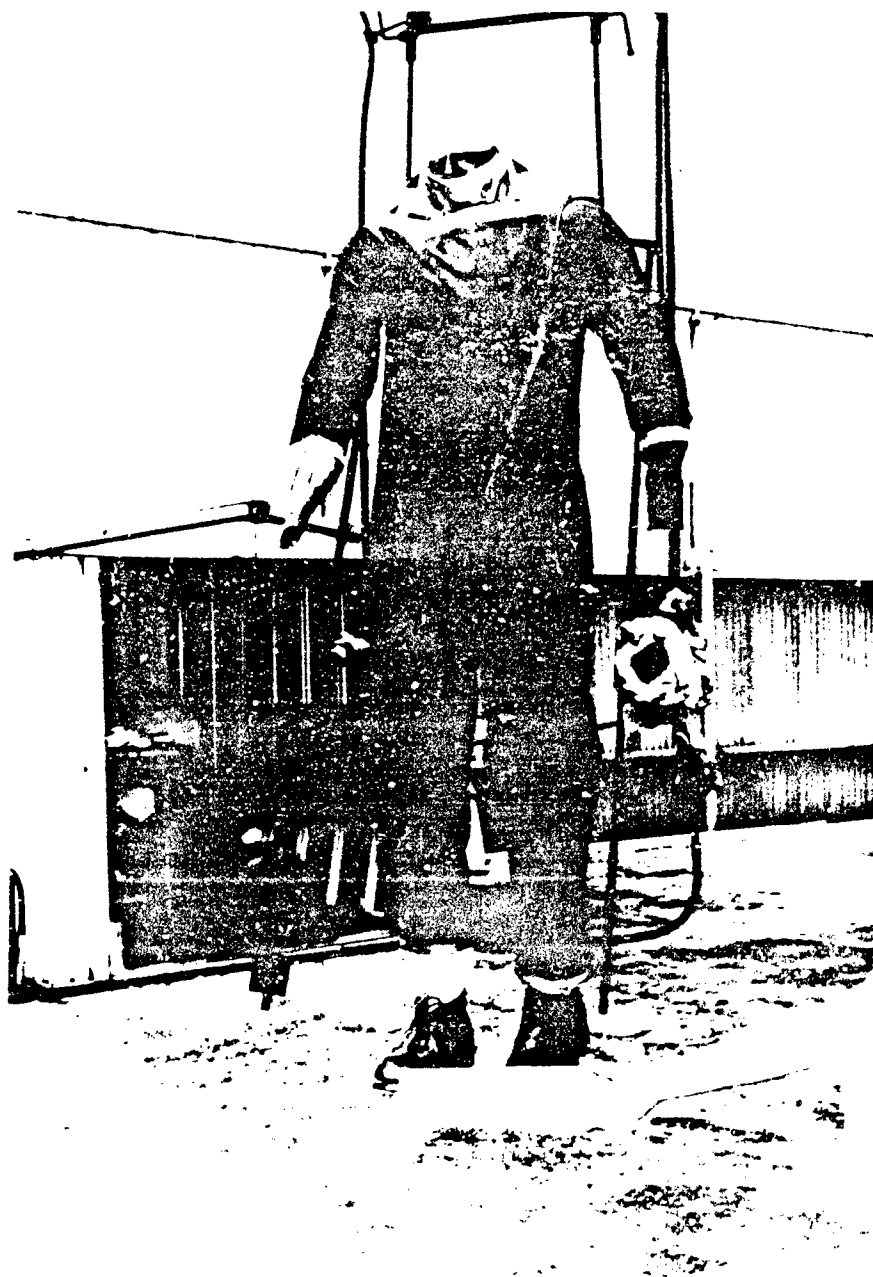


Figure 14. Orange, Front, after

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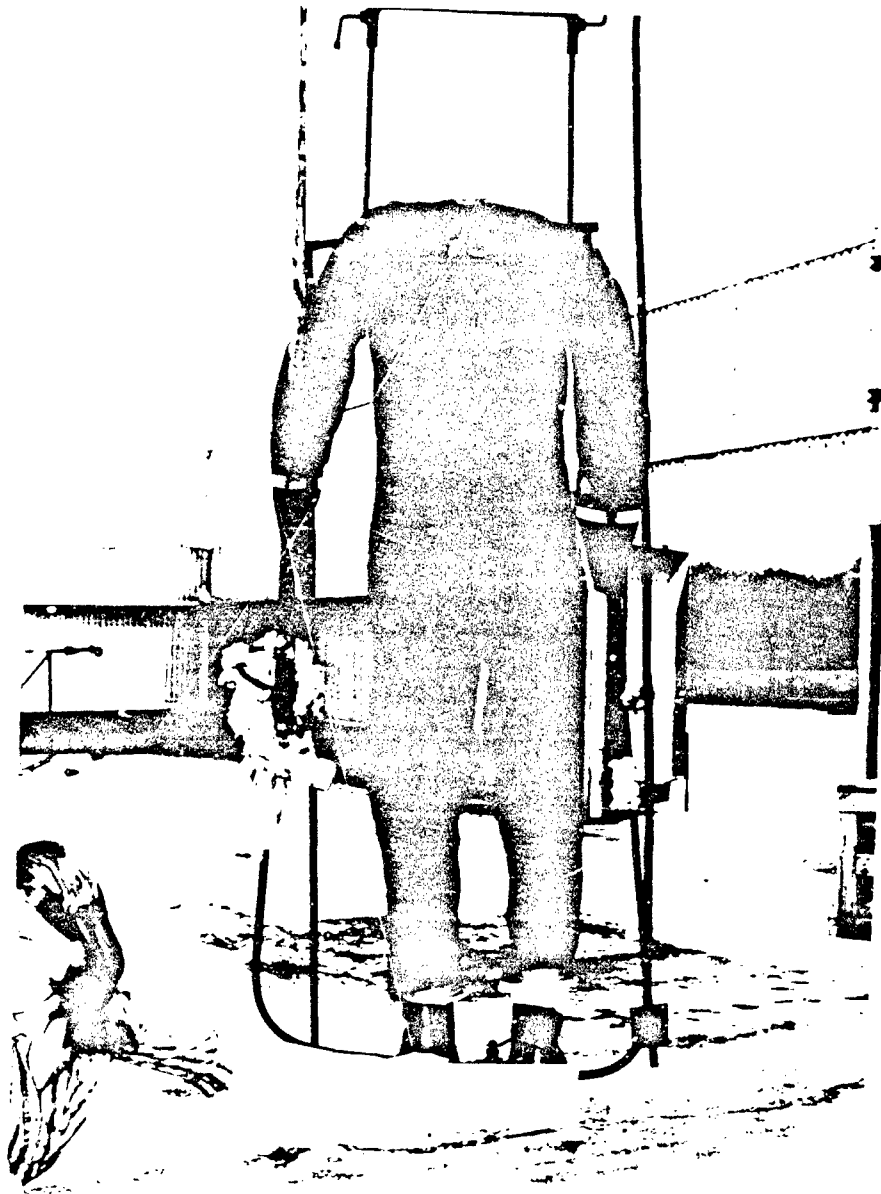


Figure 15. Orange, Back, before

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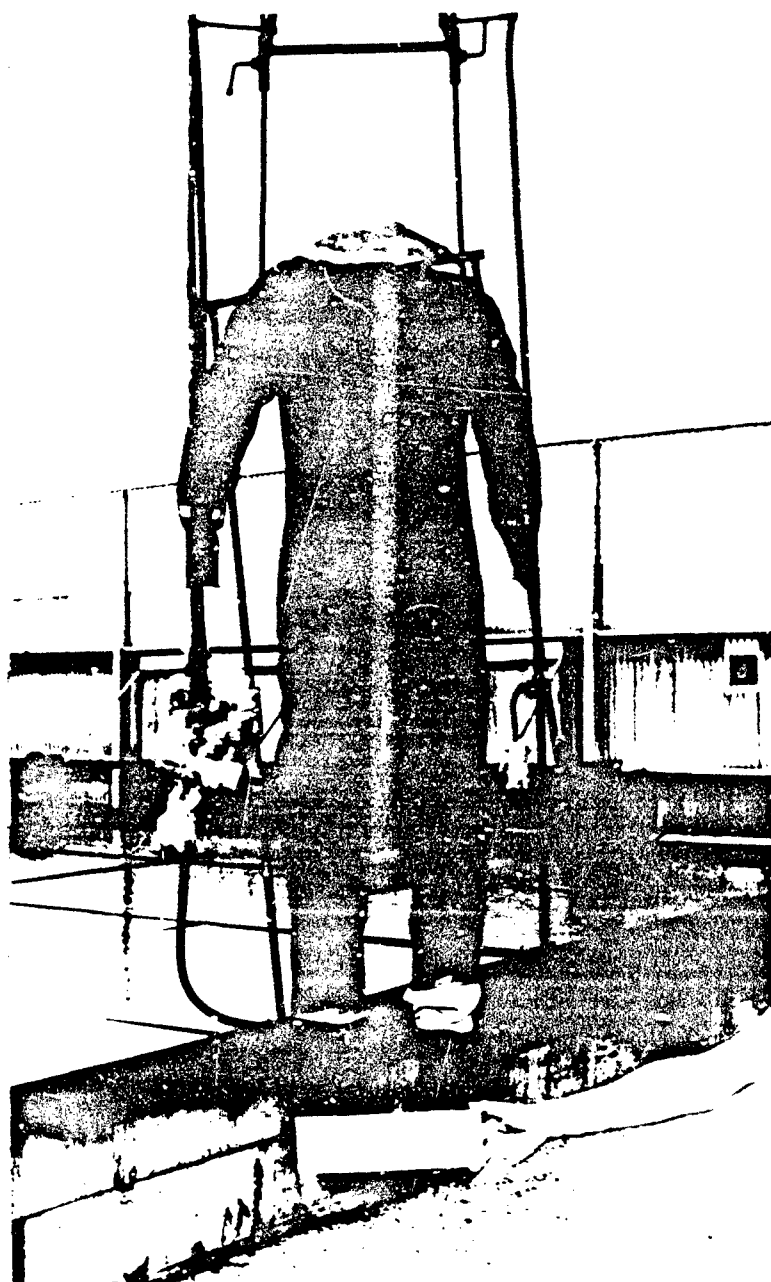


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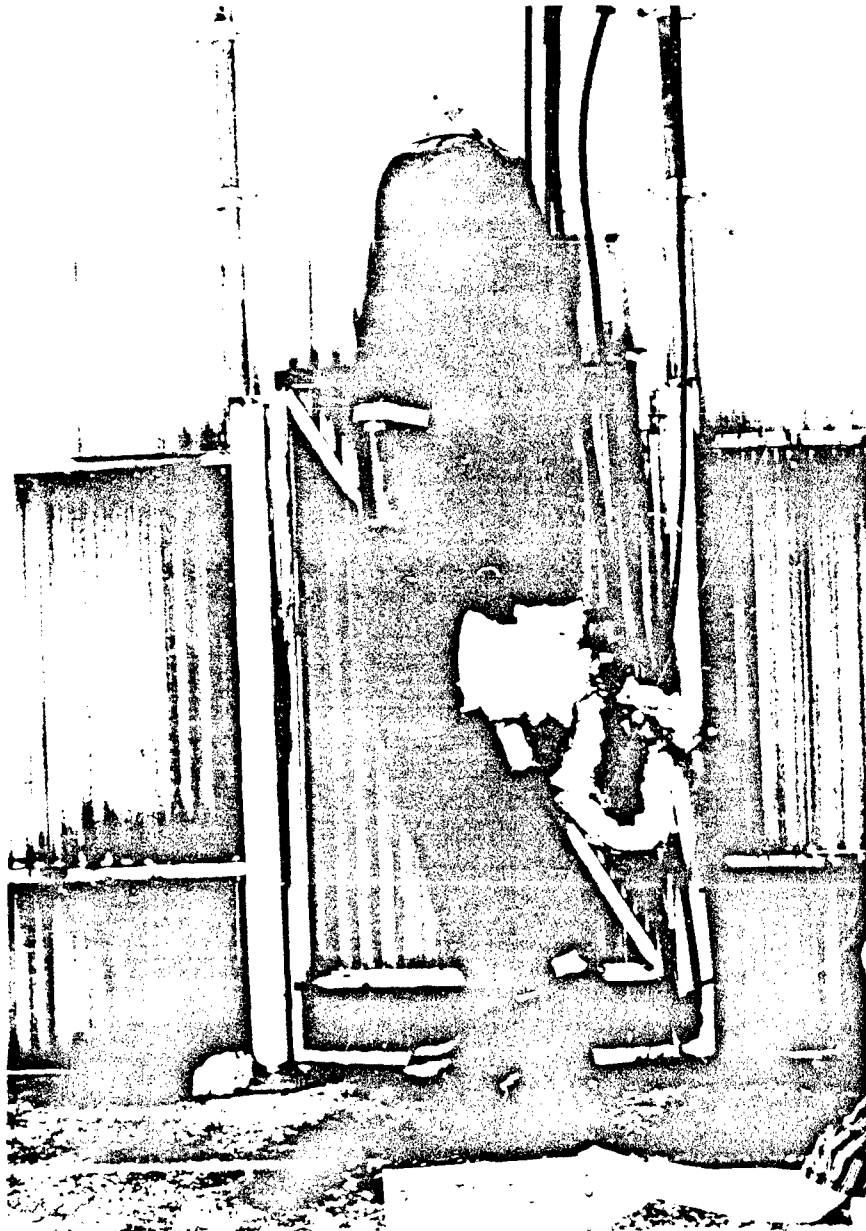


Figure 17. Orange, Side, before

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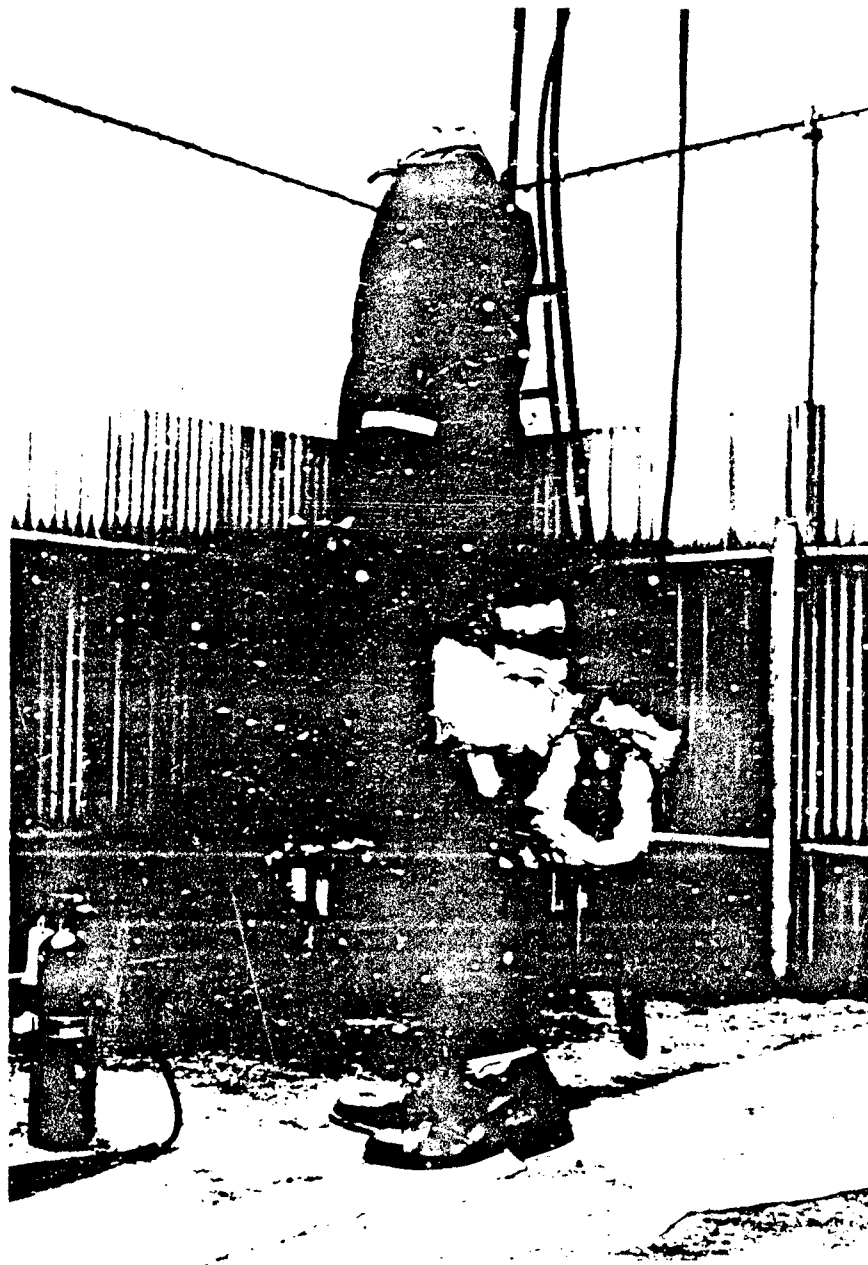


Figure 18. Orange, Side, after

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